We claim:

1. A packet routing/switching method comprising:

defining a hierarchical plurality of label switched paths (LSP)/forwarding adjacency-label switched paths (FA-LSP) through a network of nodes from a lowest (least-nested) level to a highest (most-nested) level, each LSP/FA-LSP comprising a respective sequence of nodes comprising at least a source node and a destination node and possibly one or more transit nodes;

to route/switch a packet flow from a first source node of said network of nodes to a first destination node of said network of nodes:

a) maintaining at the first node a mapping between the packet flow and a first LSP of the hierarchical plurality of LSP/FA-LSPs defined between the first source node and the first destination node;

b) at the first source node, for each packet of said packet flow, adding to the packet label switched routing information comprising an LSP label identifying the first LSP and sending the packet to subsequent node(s) in the sequence of nodes defined for the first LSP;

c) at each node to which the packet is routed/switched other than said first source node:

i) if the node is a source node of a higher level FA-LSP than the LSP/FA-LSP identified by the LSP label of the packet, changing the LSP label in the label switched routing information to indicate the source node of the higher level FA-LSP, and including in the label switched routing information hierarchy information in respect of all lower level LSP/FA-LSPs in the hierarchy leading up to the higher level FA-LSP and forwarding the packet to the next node in the sequence of nodes defined for the higher level FA-LSP;

ii) if the node is only a transit node, forwarding the packet to the next node in the sequence of nodes defined for the LSP/FA-LSP identified by the LSP label;

iii) if the node is a destination node of a higher level FA-LSP, changing the LSP label in the label switched routing information to indicate the source node of the next lower level LSP/FA-LSP indicated by the hierarchy information, and changing the hierarchy information to include only hierarchy information in respect of LSP/FA-LSPs in the hierarchy leading up to but not including the next lower level LSP/FA-LSP, and forwarding the packet to the next node in the sequence of nodes defined for the next lower level LSP/FA-LSP.

2. A method according to claim 1 further comprising:

for at least one of the LSP/FA-LSPs in the hierarchical plurality of LSP/FA-LSPs, defining an associated restoration path between the source node and the destination node of each said at least one of the LSP/FA-LSPs;

including in each packet being routed according to one of said at least one LSP/FA-LSPs an indication of whether the packet should be routed on the restoration path associated with the LSP/FA-LSP or not.

3. A method according to claim 1 further comprising maintaining in each node in the network information in association with every defined LSP/FA-LSP, the information comprising for each defined LSP/FA-LSP:

an LSP label used to uniquely identify the LSP/FA-LSP throughout the network;

an identification of the respective sequence of nodes;

an identification of the LSP label for each possible next lowest level LSP/FA-LSP inside which the defined LSP/FA-LSP may be used.

4. A method according to claim 3 wherein:

for each packet, the hierarchy information includes a component identifier associated with each level in the hierarchy below the level of the LSP label of the packet;

the component associated with one level below the level of the LSP label of the packet, when present, allowing an identification of a particular possible next lowest level LSP/FA-LSP inside which the LSP/FA-LSP defined by the LSP label is to be used in routing/switching the packet;

the components associated with subsequent lower levels allowing an identification of a particular nested hierarchy of LSP/FA-LSPs to be used for the packet.

5. A method according to claim 2 wherein the information maintained in association with every defined LSP/FA-LSP further comprises in the event there is a restoration path for the defined LSP/FA-LSP, source node, transit node, destination node identifiers for the restoration path.

6. A method according to claim 2 wherein network information in association with every defined LSP/FA-LSP, node, and updates are distributed using an in band or out of band mechanism.

7. A method according to claim 4 wherein:

the hierarchy information includes a bit position for each possible component at each level in the hierarchy, with a particular bit position being set (or cleared) to indicate a selected component as the particular possible component.

8. A method according to claim 4 wherein the hierarchy information includes a respective multi-bit component identifier field for each level in the hierarchy, each component identifier field being large enough to uniquely distinguish between possible components of the respective level in the hierarchy.

9. A method to be executed at a node within a network of interconnected nodes within which a hierarchical plurality of LSP/FA-LSPs has been defined of performing label switching of packets having an LSP label and having a possibly empty components label, the method comprising:

the node maintaining information for each LSP/FA-LSP comprising an LSP label, an identification of a source node, transit nodes if any, and a destination node, and for each LSP/FA-LSP an identification of all possible next lowest level LSP/FA-LSPs which may use the LSP/FA-LSP;

the node obtaining the LSP label, the LSP label defining a current LSP/FA-LSP of a packet to be routed;

the node obtaining the components label of the packet;

the node looking up the information for the current LSP/FA-LSP;

in the event the node is a source node of a next higher level FA-LSP of which the current LSP/FA-LSP forms a component, switching the LSP label to contain the label of the next higher level FA-LSP which is used by the current LSP/FA-LSP, and adding to the components label to include in an additional component identifier an identifier of the current LSP/FA-LSP;

in the event the node is the destination node of the current LSP/FA-LSP, determining from the components label and the maintained information another LSP label for a lower level LSP/FA-LSP from a component identifier for the lower level and removing the component identifier for the lower level from the components label, and changing the LSP label to the another LSP label for the lower level hierarchy determined from the components label;

the node re-applying the components label to the packet;

the node re-applying the LSP label to the packet; and

the node changing an output interface such that the packet is forwarded to an appropriate next node.

10. A method of performing label switched routing comprising:

at each node in a network of nodes, for each packet removing a previous LSP header and adding a new header containing a full LSP label for a current LSP/FA-LSP, and containing components identifiers which allow local identification of a hierarchy of LSP/FA-LSPs of which the current LSP/FA-LSP forms a part.

11. A method according to claim 1 adapted to route IP packets.

12. A packet routing/switching system comprising:

a network of interconnected nodes through which is defined a hierarchical plurality of label switched paths (LSP)/forwarding adjacency-label switched paths (FA-LSP) from a lowest (least-nested) level in which LSPs are defined between edge nodes of the network to a highest (most-nested) level, each LSP/FA-LSP comprising a respective sequence of nodes comprising at least a source node and a destination node and possibly one or more transit nodes;

wherein each edge node is adapted to maintain a mapping between each packet flow entering the network at the edge node and a respective first LSP of the hierarchical plurality of LSP/FA-LSPs defined between the edge node and a destination node in the network for the packet flow;

wherein each edge node is further adapted to add to each packet of a given packet flow switched routing information

comprising an LSP label identifying the respective first LSP to which the packet flow is mapped and to send the packet to subsequent node(s) in the sequence of nodes defined for the respective first LSP;

wherein each node other than an edge node is adapted to perform label switching by:

i) if the node is a source node of a higher level FA-LSP than the LSP/FA-LSP identified by the LSP label of the packet, changing the LSP label in the label switched routing information to indicate the source node of the higher level FA-LSP, and including in the label switched routing information hierarchy information in respect of all lower level LSP/FA-LSPs in the hierarchy leading up to the higher level FA-LSP and forwarding the packet to the next node in the sequence of nodes defined for the higher level FA-LSP;

ii) if the node is only a transit node, forwarding the packet to the next node in the sequence of nodes defined for the LSP/FA-LSP identified by the LSP label;

iii) if the node is a destination node of a higher level FA-LSP, changing the LSP label in the label switched routing information to indicate the source node of the next lower level LSP/FA-LSP indicated by the hierarchy information, and changing the hierarchy information to include only hierarchy information in respect of LSP/FA-LSPs in the hierarchy leading up to but not including the next lower level LSP/FA-LSP, and forwarding the packet to the next node in the sequence of nodes defined for the next lower level LSP/FA-LSP.

13. A system according to claim 12 wherein:

for at least one of the LSP/FA-LSPs in the hierarchical plurality of LSP/FA-LSPs, an associated restoration path is defined between the source node and the destination node of each said at least one of the LSP/FA-LSPs;

in each packet being routed according to one of said at least one LSP/FA-LSPs an indication is included of whether the packet should be routed on the restoration path associated with the LSP/FA-LSP or not.

14. A system according to claim 12 wherein each node in the network maintains information in association with every defined LSP/FA-LSP, the information comprising for each defined LSP/FA-LSP:

an LSP label used to uniquely identify the LSP/FA-LSP throughout the network;

an identification of the respective sequence of nodes;

an identification of the LSP label for each possible next lowest level LSP/FA-LSP inside which the defined LSP/FA-LSP may be used.

15. A system according to claim 14 wherein:

for each packet, the hierarchy information includes a component identifier associated with each level in the hierarchy below the level of the LSP label of the packet;

the component identifier associated with one level below the level of the LSP label of the packet, when present, allowing an identification of a particular possible next lowest level LSP/FA-LSP inside which the LSP/FA-LSP defined by the LSP label is to be used in routing/switching the packet;

the component identifier associated with subsequent lower levels allowing an identification of a particular nested hierarchy of LSP/FA-LSPs to be used for the packet.

16. A system according to claim 13 wherein the information maintained in association with every defined LSP/FA-LSP further comprises in the event there is a restoration path for the defined LSP/FA-LSP, source node,

transit node, destination node identifiers for the restoration path.

17. A method according to claim 13 wherein the information in association with every defined LSP/FA-LSP and updates to the information are distributed using an in band or out of band mechanism.

18. A system according to claim 15 wherein:

the hierarchy information includes a bit position for each possible component at each level in the hierarchy, with a particular bit position being set (or cleared) to indicate a selected component as the particular possible component.

19. A system according to claim 15 wherein the hierarchy information includes a respective multi-bit component identifier field for each level in the hierarchy, each component identifier field being large enough to uniquely distinguish between possible components of the respective level in the hierarchy.

20. A network of interconnected nodes adapted to perform label switched routing by, at each node in a network of nodes, for each packet removing a previous LSP header and adding a new header containing a full LSP label for a current LSP/FA-LSP, and containing component identifiers which allow local identification of a hierarchy of LSP/FA-LSPs of which the current LSP/FA-LSP forms a part.

21. A network node within a network of interconnected nodes within which a hierarchical plurality of LSP/FA-LSPs has been defined, the network node comprising:

a network information repository comprising for each LSP/FA-LSP an LSP label, an identification of a source node, transit nodes if any, and a destination node, and for each LSP/FA-LSP an identification of all possible next lowest level LSP/FA-LSPs which may use the LSP/FA-LSP;

a packet router adapted to route each packet by:

obtaining an LSP label of the packet, the LSP label defining a current LSP/FA-LSP of the packet;

obtaining a components label of the packet;

looking up the information in the network information repository for the current LSP/FA-LSP;

in the event the node is a source node of a next higher level FA-LSP of which the current LSP/FA-LSP forms a component, switching the LSP label to contain the label of the next higher level FA-LSP which is used by the current LSP/FA-LSP, and adding to the components label to include in an additional component identifier an identifier of the current LSP/FA-LSP;

in the event the node is the destination node of the current LSP/FA-LSP, determining from the components label and the maintained information another LSP label for a lower level LSP/FA-LSP from a component identifier for the lower level and removing the component identifier for the lower level from the components label, and changing the LSP label to the another LSP label for the lower level hierarchy determined from the components label;

re-applying the components label to the packet;

re-applying the LSP label to the packet; and

changing an output interface such that the packet is forwarded to an appropriate next node.